

Quantifying Economic Value of Air Quality Improvement Schemes in Quarry Mining: A Social and Environmental Perspective

Tochukwu Ngwu¹, Komsoon Somprasong², Chinwe Oramah³

¹Chiang Mai University, Chiang Phueak, Mueang Chiang Mai, Thailand, ²Chiang Mai University, Chiang Phueak, Mueang Chiang Mai, Thailand, ³Arctic University of Norway, Harstad, Norway

The quarrying industry has played a crucial role in global economic advancement for several decades, especially in the construction and energy sectors. However, quarrying operations contribute to significant environmental degradation, predominantly air pollution, which has extensive implications for ecosystem health. Consequently, various regulatory frameworks and environmental protection schemes are stipulated by policymakers and regulatory bodies to ensure that quarrying operations are environmentally sustainable. While these schemes ensure compliance with environmental policies, there has been limited emphasis on the quantification of its resulting economic value, this leads to an inability to ascertain its efficiency and capacity to deliver measurable value for stakeholders. To address this, the study evaluates the efficiency of air quality improvement schemes in two quarry mines, quantifies its environmental and social benefits in monetary terms and determines the economic value generated. Additionally, we conduct a comparative analysis of the selected quarries to explore the key factors influencing the variations in economic value derived from the schemes. To account for uncertainty in estimating the derived economic benefits, we apply Monte Carlo Simulation to analyze the sensitivity of results to changes in key assumptions—specifically, pollutant reduction levels and the size of the affected population. This approach facilitates an understanding of the impact of each key assumption on the overall economic value generated by the schemes. Ultimately, this study will provide new insights into the broader economic contributions of air quality improvement schemes, highlighting their inputs beyond regulatory compliance. The integration of Monte Carlo Simulation in the economic evaluation will offer a data-driven approach for evaluating environmental and social returns under uncertainties, facilitating more informed decision-making and strategic resource allocation in quarry operations.